Natural Scenic Beauty of Wisconsin Wetlands

A Technical Report to the
Bureau of Waterways

from the
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About This Report

This report presents results from an online panel study conducted in 2023. Natural scenic beauty is a key component of wetland functional values and is specifically identified as a wetland water quality standard in s. NR 103.02, Wis. Adm. Code. Despite the importance of this key parameter and functional value of wetlands, Wisconsin DNR has lacked a calibrated tool to make regulatory decisions based on natural scenic beauty. The purpose of this project was to inform development of a decision support tool to facilitate rapid functional value assessments or other similar efforts related to natural scenic beauty. The study was conducted to support the Bureau of Waterway's wetland permitting program. This report presents study findings, interprets the information within pertinent contexts, and identifies potential lines of additional inquiry. This report does not, however, include specific recommendations or policy prescriptions.

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Introduction

The Wisconsin Department of Natural Resources (DNR) manages wetlands to promote, protect, restore, enhance, and preserve the quantity, quality, and diversity of Wisconsin's wetlands. To protect the State's wetlands, the legislature and the DNR have adopted laws such as s. 281.36, *Wis. Stats*., which establishes the wetland permitting program, and rules such as ch. NR 103, Wis. Admin. Code, which outlines water quality standards for wetlands. Pursuant to s. 281.36(3g), *Wis. Stats*., wetland individual permits can only be authorized if a project does not cause significant adverse impacts to wetland functional values.

Natural scenic beauty is a key component of wetland functional values and is specifically identified as a wetland water quality standard in s. NR 103.02, Wis. Adm. Code. Despite the importance of this key parameter and functional value of wetlands, the DNR has lacked a calibrated tool to make regulatory decisions based on natural scenic beauty. This gap can cause regulatory uncertainty for stakeholders and regulators alike. As a result, we undertook this project to inform development of a decision support tool to facilitate rapid functional value assessments or other similar efforts related to natural scenic beauty.

Assessment of Natural Scenic Beauty

Over fifty years of landscape perception research has given rise to several competing paradigms for landscape assessment. These include the expert, psychophysical, cognitive, and experiential approaches (Zube et al., 1982). The expert paradigm, as its name implies, relies on the evaluation of the landscape by skilled observers, trained in design principles, ecology, or resource management fields where sound management is assumed to lead to intrinsic aesthetic qualities. The psychophysical approach allows testing by segments of the public and assumes that correlations exist between landscape properties and observers' ratings. The cognitive paradigm involves the search for meaning associated with landscapes based on past experiences, future expectations, and socio-cultural conditioning. Finally, the experiential approach considers the iterative process of human-landscape interaction to be the basis of landscape value. Of these paradigms, only the expert and psychophysical approaches are commonly used in resource management settings.

The expert paradigm has been the *de facto* approach to account for natural scenic beauty functional values in wetland permitting processes in the sense that the DNR has relied on its wetland biologists' trained opinions to inform decisions. A concern arises, however, to the extent that perceptions of observers trained to appreciate characteristics of the landscape associated with ecological functional values differ from those of the public. Such potential differences may create regulatory uncertainty and the potential for conflict between the DNR and its stakeholders.

Whereas the expert approach discounts laypersons' perceptions, the psychophysical paradigm embraces them. This approach examines the relationship between physical properties of a landscape and observers' evaluations of that landscape and was initially developed for the scenic evaluation of forest landscapes (Daniel and Boster, 1976). As such, it has been extensively used to study several issues related to forest management including classifying biophysical factors related to aesthetics (e.g., Brown and Daniel, 1986; Haider, 1994), and identifying the aesthetic effects of timber harvesting (Brown, 1987; Brown and Daniel, 1987; Brunson and Shelby, 1992; McCool et al., 1986) and insect infestation (Buhyoff et al., 1982). While some studies have focused on boreal forested shorelines (Hunt and Haider, 2000; Haider and Hunt, 2002; Hunt and Haider, 2004; Beardmore, 2005), no scenic beauty studies, to our knowledge, have explicitly looked at wetlands in a North American context.

For this study, we adopted a psychophysical approach (i.e., the scenic beauty estimation method; Daniel and Boster, 1976) for three reasons. First, it requires no special training on the part of observers, allowing the participation of members of the public and stakeholders directly affected by the scenic quality of the landscapes depicted. Second, this paradigm links observers' ratings to biophysical data associated with the landscape. While resource managers have little control over the cognitive process of aesthetic evaluation, this method will allow the DNR to predict the aesthetic quality based on measurable landscape characteristics. Finally, scenic beauty estimation has been used to establish a nearly perfect linear relationship between perceived scenic beauty and willingness to pay (Daniel et al., 1989), suggesting that scenic beauty estimates (SBEs) are a robust measure of aesthetic value. The validity of photo-based preference judgements has also been established (Brown et al., 1988), and while direct in-person ratings of scenic views may differ from photo-based ratings, the two ratings were highly correlated. Photo-based scenic beauty measures, therefore, provide a reasonably good indication of relative onsite scenic quality.

Methods

Photo Collection and Cataloguing

DNR field staff collected photographs for use in our survey while conducting site visits between July 14 and August 31, 2022. We chose this period during the middle of the growing season as wetland vegetation growth was at an extent that staff could identify plant communities and wetland types. Field staff were provided training and instructions related to a standard a photography protocol (Figure 1) as well as use of Survey 123 to submit their images.

While uploading their images to Survery123, staff were asked to answer a series of questions that would assist with describing the image and future coding. Field staff identified the wetland type depicted in the image, the presences of features such as open water, wildflowers, driveways, berms, roads, powerlines, and buildings, how visible these features were (visible, somewhat obscured, mostly obscured), how they would rate plant diversity (low, medium, high), to what extent the vegetation depicted in the photo(s) was comprised of invasive species (less than 5%, 5 to 25%, 26 to 50%, 51 to 75%, more than 75%, how they would rate the scenic beauty of the wetland based on a ten point scale (1="Extremely Unattractive," 10="Extremely Attractive"), wetland type (wet prairie, marsh, mature forested, immature forested, sedge meadow, tall shrub, or farmed wetland), and whether they wanted to include any other information that they thought important to consider in an aesthetic assessment of the wetland shown in the photo(s). For the additional information question, many field staff provided the location, the specific type of wetland present, whether it was a mitigation bank site, or features such as a cell tower or boardwalk that they wanted to point out. They could also submit multiple photos for a single response.

- **Do** use the normal (not telephoto or wide angle) lens of your modern smartphone (at least 5 Megapixels).
- **Do** enable location services for your camera app. This makes logging much easier.
- **Do** take photos during full daylight hours to avoid prominent shadows. No "Golden Hour" photos of sunrises or sunsets.
- **Do** hold the camera parallel to the ground (neither angled up nor down), at approximately eye level when standing. If taking a photo from an elevated position, angle the camera to follow the terrain. The following guidelines can help with composition:
    - The sky should occupy no more than 25% of the photo area. Avoid inclusion of the sun in the picture.
    - Water (if taken from offshore) should occupy about 20% of the photo area. (Move closer or farther from shore to achieve this)
- **Do not** use a digital or optical zoom, digital filters, or post processing to alter or enhance the photo.
- **Do not** include temporary features in the composition of the photo such as people, vehicles, wildlife, or equipment.

Figure 1. *Protocol for taking photographs.*

Field staff responses, along with the accompanying photo, served as a base for coding efforts that occurred after the entries were collected.

Participating field staff submitted 144 responses that included a total of 260 images. Those images were reviewed to check if protocols were met and for quality. Pictures that were poorer quality (too blurry, dark, close, poor resolution, etc.) or had identifying characteristics such as location information or people present were not used. We further pared down photos by choosing one image from each response so that images chosen showed as much of the wetland as possible, were clear, and had features easily distinguishable to a potential survey taker.

The final selection of images was then coded, using the staff responses as a base, so key characteristics and features could be identified and used in future data analyses. Images were reviewed to assess whether there were common features such as open water, roads, flowers, buildings, etc. present which could then be used to refine the coding of the images. The following landscape characteristics were used to code each of the selected photos where 0 would mean that the feature was absent in the scene and 1 would mean that it was present: anthropogenic structures (buildings, roads, trails, boardwalks, powerlines, cell towers, poles, berms, fences, etc.), dead trees, dead or dried vegetation, flowers, water, bare soil, hills, and plants and the plant diversity, invasive species extent, and wetland type as identified by field staff. Also coded were field staff plant diversity ratings (1=low, 2=medium, 3=high) and invasive species extent (1 = less than 5%, 2 = 5 to 25%, 3 = 25 to 50%, 4 = 50 to 75%, 5 = 75% or higher). Examples of images that were coded and used as part of the survey are presented on the following pages, with captions describing features coded in the dataset.

Example 1. *A tall shrub wetland (wetland type) with landscape characteristics of dead or dried vegetation, hills, and flowers. It was rated as having high plant diversity*

Example 2. *A marsh (wetland type) with landscape characteristics of anthropogenic structures (railroad, powerline), dead trees, and water. It was rated as having low plant diversity with an invasive species extent of 50 to 75%*

Example 3. *A farmed wetland (wetland type) with landscape characteristics of water and bare soil. It was rated as having low plant diversity with an invasive species extent of 75% or higher.*

Survey Design and Administration

The core questions of the survey focused on the scenic beauty estimation task, in which respondents judged images depicting wetland landscapes on a 10-point integer scale ranging from 1 (“not-at-all attractive”) to 10 (“very attractive”). In addition to four photographs that were shown to all respondents to provide a common baseline, each respondent rated 21 images selected at random from a bank of 100 photographs. We also randomized the order in which images were selected to reduce the potential for learning effects (photos seen first) and survey fatigue (surveys seen last) to bias respondents’ SBEs.

Data Validation

Survey data quality were evaluated for potential issues related to random or strategic response patterns (i.e., speeding and straight lining). We removed responses from individuals who completed the survey in under a minute, and those who did not vary in the rating scores given to all photographs that they saw. Quota sampling ensured that the dataset was representative of the wider Wisconsin population in terms of age, gender, and income distribution.

Scenic Beauty Estimation

Respondents’ raw ratings were transformed into a standardized interval scale index of preference (Daniel et al., 1989). This scaling procedure was originally developed for scenic evaluation of forest landscapes (Daniel and Boster, 1976), and is based on Thurstone’s “Law of Categorical Judgement” (Torgerson, 1958).

To calculate Scenic Beauty Estimates (SBEs), three computational steps were undertaken. First, the mean z-score of each stimulus ($\bar{z}_j$) was calculated (Brown and Daniel, 1990). In the second step, the same procedure was used to calculate the mean z-score of the baseline stimuli ($\bar{\bar{z}}_B$). The SBE for each stimulus was then calculated by subtracting the $\bar{\bar{z}}_B$ from the $\bar{z}_j$ and multiplying the result by 100 to remove the decimals.

$$SBE_j = \left(\bar{z}_j - \bar{\bar{z}}_B\right) \times 100 \qquad (1)$$

This resulted in an equal-interval scale measure of perceived values, which had been standardized to a common baseline.

The resultant SBEs are relative measures rather than absolute measures. Thus, this approach is less concerned about the absolute values of each score than their relative magnitude compared to one another. As long as most respondents made a good faith effort to rate the scenic quality of each photo as evidenced by internal consistency between ratings of baseline photos (evaluated by all respondents) and experimental subsets (randomly selected photos that are seen by some respondents but not others – to reduce response burden and survey fatigue), SBEs provide a reliable metric of aggregated perceptions of the aesthetic quality of landscapes depicted in the photographs (Daniel and Boster, 1976).

The SBE procedure is designed to minimize potential biases that may affect an individual’s response, such as the tendency for respondents to differ in the range of scale values within which they tend to select scores. Because the SBE is derived from many replications of the experiment, it minimizes the potential for systematic biases associated with extreme responses. This aspect of the method, however, is also a limitation. Because the dependent variable is aggregated across the pool of survey respondents, heterogeneity of preferences within the population tends to result in kurtosis in the distribution of estimates. In other words, opposing viewpoints may cancel each other out. To address this limitation, estimates were calculated for each individual respondent (i):

$$SBE_{ij} = \left(z_{ij} - \bar{z}_B\right) \times 100 \qquad (2)$$

The resulting estimates are therefore standardized by the baseline images to adjust for each respondent having evaluated a different set of images. The resulting SBEs are thus standardized to the common set of images without discarding individual preferences.

Once the SBEs have been calculated for each photograph, they were then treated as the dependent variable in regression analyses to test for relationships with hypothesized drivers of aesthetic value (i.e., biophysical characteristics of the landscape coded to each photo). Whereas the aggregated measure of SBE treats each image as the unit of observation in the analysis (N=102), analysis of individual SBE_i focuses on the respondents as cases (N=897; N_{staff}=32), while accounting for individual rating tasks as 24,288 repeated measures.

Regression Analysis

Analysis of scenic beauty typically relies on multiple linear regression. The model to predict SBE of image *x* can be formulated as follows (Vermunt and Magidson, 2005):

$$SBE_x = \alpha_{x0} + \sum_{q=1}^{Q} \beta_{xq} * z_q \qquad (3)$$

In this equation, $\alpha_{x0}$is an intercept value, and β_{xq} is the regression coefficient corresponding to the contribution to the aesthetic rating of landscape feature *q* whose value is *z*. We ran this model separately for the panel and staff respondents, and then jointly estimated using panel membership to segment the combined sample to facilitate comparison between the two groups.

To better account for heterogeneity within the online panel of respondents, we used a latent choice regression model to find groups or subtypes within the online panel of respondents (called "latent classes"), defined to maximize the differences among regression coefficients among the groups. An important extension of the Latent Class Regression model is obtained by making class membership dependent on covariates (Kamakura et al., 1994; Vermunt, 1997), which in this case are the characteristics of the respondent. The probability of belonging to a given latent class (l), follows a multinomial form as follows:

$$P(l|z_n^{cov}) = \frac{e^{\alpha_{nl} + \sum_{c=1}^{C}(\beta_{nlc} \times z_{nlc})}}{\sum_{l=1}^{L} e^{\alpha_{nl} + \sum_{c=1}^{C}(\beta_{nlc} \times z_{nlc})}} \qquad (4)$$

In this equation, the probability that individual *n* belongs to latent class *l depends on* a class-specific constant (α_{nl}), and the coefficients (β_{nlc}) and values (z_{nlc}) of *C* covariates.

Image attributes and respondent characteristics were treated as categorical variables and effects-coded to center each attribute's values at zero (Bech and Gyrd-Hansen, 2005). The analysis accounted for the panel structure of the dataset (26 observed ratings made by each respondent) and was conducted using Latent Gold 5.1 software by Statistical Innovations, Inc. (Vermunt and Magidson, 2005).

Model selection was based on minimizing the Bayesian Information Criterion (BIC) and followed a stepwise process to evaluate goodness-of-fit.

Scenic Beauty Estimation Tool

While examining individual parameters in the model provides key insights into how trained (DNR wetland biologists) and untrained (online panelists) observers perceived the aesthetic qualities of wetland landscapes, it is useful to evaluate the combined effects of these parameters. To this end, we built an estimation tool in Microsoft Excel to predict SBEs for any combination of attributes that were included in the regression model by feeding parameter estimates for a given scenario through the model equation (4). To standardize estimates across groups, predicted SBEs were converted to percentiles of the range between the lowest and highest possible predicted SBEs for the group.

Results

Descriptive Statistics

We used coarse age, gender and income categories to define response quotas within the online panel that matched distributions from the 2020 U.S. Census. Therefore, their distribution (Figure 2) mirrors those of the broader public.

We also asked respondents to identify the region of Wisconsin in which they lived, as well the urban/rural character of the area in which they lived (Figure 3). As may be expected based on the distribution of major population centers in Wisconsin, a plurality of respondents live in the southeastern part of the state (Milwaukee; 37%), followed by the northeast (Green Bay; 22%), south central (Madison; 20%), west central (Lacrosse and Eau Claire; 14%) and northern (7%) regions of the state. Proximity to urban centers is also evident as most respondents characterized themselves as living in an urban (31%) or suburban (40%) area. By contrast 26 percent identified themselves as living in a rural area, off-farm, while only three percent indicated that they lived on a farm.

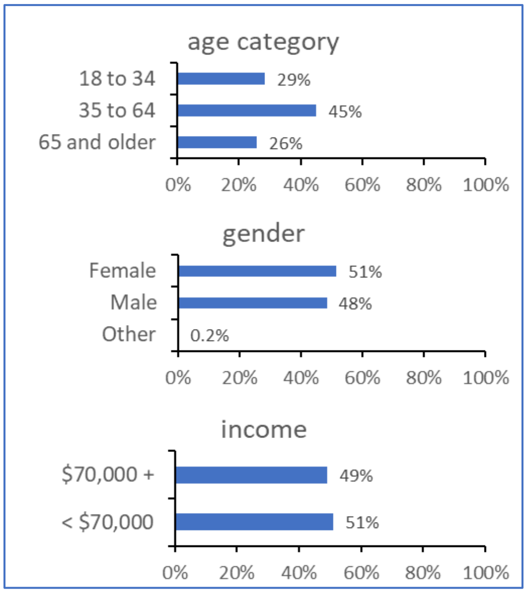

Figure 2. *Demographic characteristics of respondent panel upon which sampling quotas were based.*

Finally, we asked respondents to select the outdoor recreational activities that they enjoy from a list of eight activities that may be associated with wetland environments (Figure 4). Hiking was the most popular activity, with most respondents (56%) indicating that they enjoy it, followed by fishing (40%). Paddle sports (canoeing, kayaking or paddleboarding) and bird-watching were both enjoyed by approximately a third of respondents (34% each), while about one in five enjoyed hunting and motorboating (19% each). Foraging (14%) and trapping (4%) were the least popular activities listed.

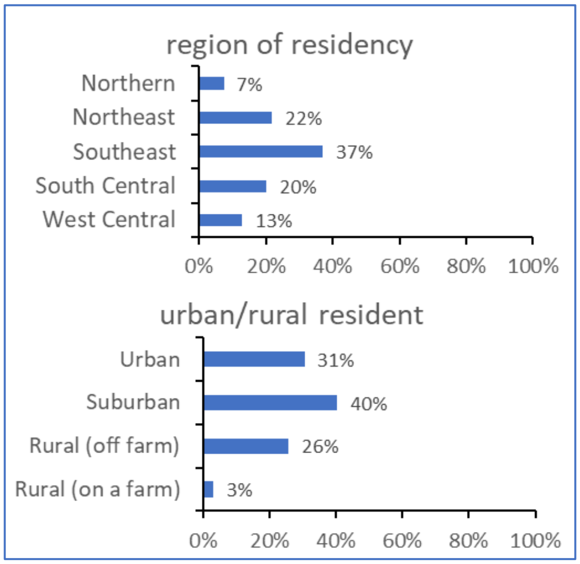

Figure 3. *Respondent residential information.*

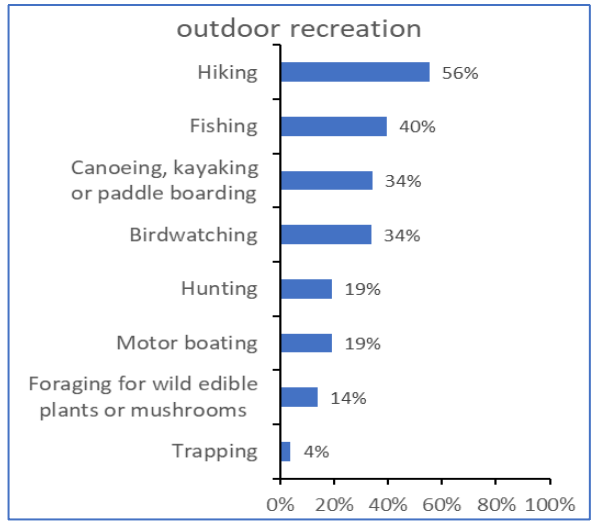

Figure 4. *Outdoor recreation participation.*

Scenic Beauty Estimation

The distribution of SBEs (Figure 5) at the aggregated level indicates that overall, DNR staff differentiated the images based on their scenic qualities to a greater extent than did the panel. In other words, their estimates showed less of a central tendency. The wider distribution of the individualized SBEs for the panel, on the other hand, demonstrates considerable heterogeneity in their perceptions. Staff were also more critical in their ratings, as demonstrated by the left skew in their distribution relative to that of the panel. The distribution of the individual SBEs reinforces the finding that staff tended to rate the natural scenic beauty of more harshly.

Model Summary Statistics and Candidate Model Selection

All candidate models included the full set of landscape characteristics coded to the images. The first set of models (Table 1, Step 1) focused on comparing the effects of landscape characteristics on aesthetic evaluations between DNR staff and the online panel. The R^2 values indicates that the staff-focused model (R^2=0.39) had a better fit than did the panel model (R^2=0.07), suggesting that perceptions are more similar among staff than they are among panel members. A jointly estimated model that allows comparison of parameter values between staff and panelists is presented in the following section.

To account for the heterogeneity in perceptions observed in the SBE data of the panel, the first step of the model selection process was to identify the optimal number of latent classes to include in the model from a suite of ten candidate models. In each case class membership was solely determined by the effects of image characteristics on the individual's SBE. Based on BIC, the 6-class solution was chosen to advance to the next step.

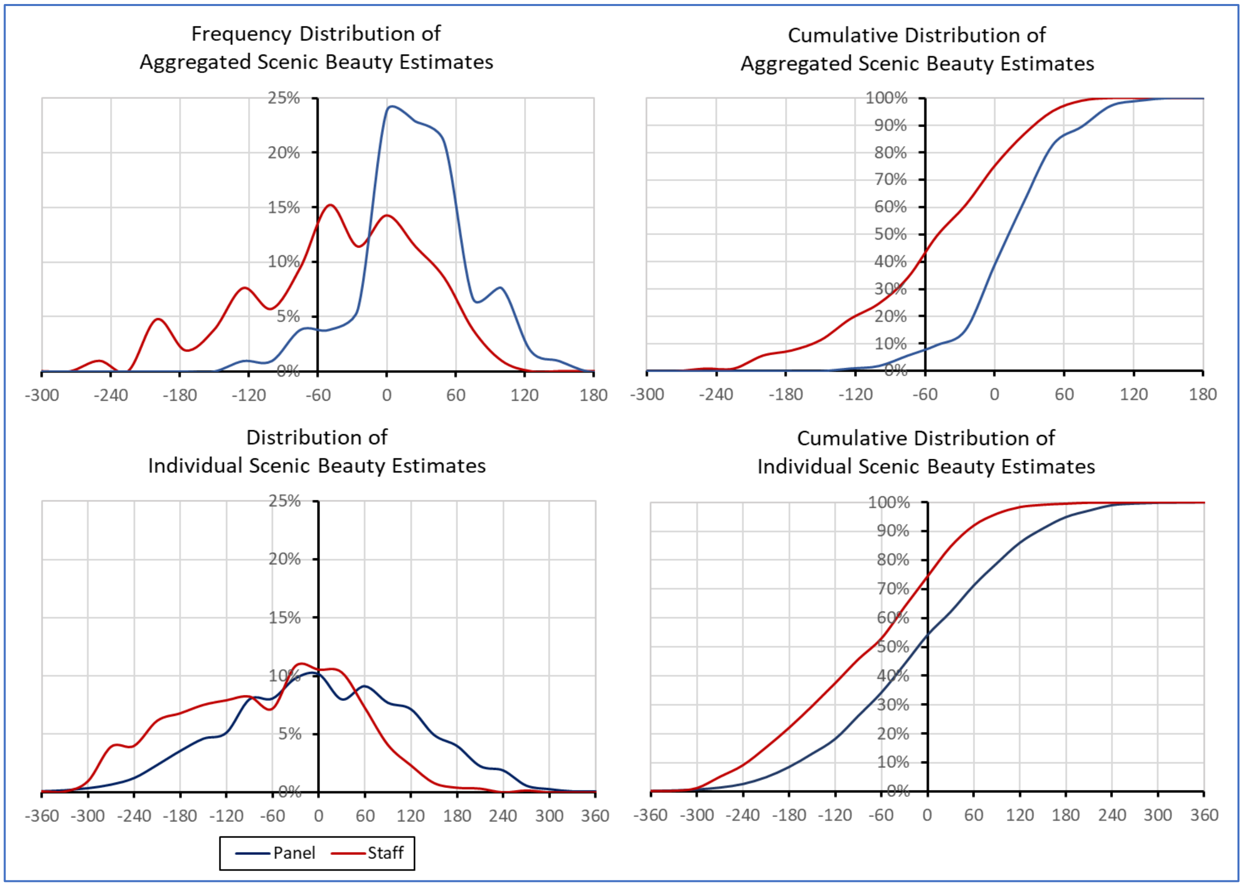

Figure 3. *Distributions of Scenic Beauty Estimates across images of wetland landscapes used in the study.*

In the final step, all covariates (i.e., respondent characteristics) were included in a 6-class model. The covariate with the highest p-value was then then removed and the model rerun. This process was repeated until no covariates remained. The model with the lowest BIC was then selected. The selected model retained age and three recreational activities (hiking, bird-watching, and trapping) as informative covariates to predict class membership.

Table 1. Summary statistics of regression models evaluated as part of this study. Step 1 models focused on the entire respondent pools, while models evaluated in step 2 and 3 focused on maximizing information from the heterogenous online panel group. Parameters from the models indicated in bold are presented in this report.

Step	Sample	Model	LL	BIC(LL)	AIC(LL)	Npar	Class.Err.	R^2
1	Staff	1-Class Regression	-7340.4	14756.3	14724.8	22	0.0%	0.386
	Panel	1-Class Regression	-141519.0	283187.6	283082.0	22	0.0%	0.070
	Staff vs Panel	**Known Class Regression**	**-148995.3**	**298298.2**	**298080.6**	**45**	**0.0%**	**0.102**
2	Panel - No Covariates	2-Class Regression	-138983.5	278273.0	278056.9	45	2.2%	0.303
		3-Class Regression	-138363.2	277188.8	276862.3	68	5.4%	0.362
		4-Class Regression	-137998.5	276616.0	276179.1	91	6.0%	0.388
		5-Class Regression	-137882.7	276540.8	275993.5	114	9.6%	0.406
		6-Class Regression	**-137788.3**	**276508.4**	**275850.6**	**137**	**13.0%**	**0.417**
		7-Class Regression	-137722.2	276532.6	275764.4	160	13.8%	0.427
		8-Class Regression	-137660.9	276566.5	275687.9	183	16.4%	0.434
		9-Class Regression	-137614.9	276630.9	275641.8	206	17.6%	0.442
		10-Class Regression	-137563.5	276684.5	275585.0	229	18.0%	0.447
3	Panel 6-class	All Covariates	-137698.7	277077.3	275891.3	247	11.5%	0.415
	Panel 6-class	Stepwise remove Urban/Rural	-137773.2	277124.2	276010.3	232	8.7%	0.407
	Panel 6-class	Stepwise remove Income	-137703.7	276951.2	275861.4	227	11.6%	0.414
	Panel 6-class	Stepwise remove Gender	-137708.2	276892.3	275850.4	217	10.7%	0.414
	Panel 6-class	Stepwise remove Region	-137718.6	276743.1	275821.2	192	10.8%	0.414
	Panel 6-class	Stepwise remove Motorboat	-137718.8	276709.4	275811.5	187	10.8%	0.414
	Panel 6-class	Stepwise remove fish	-137720.8	276679.4	275805.6	182	11.1%	0.415
	Panel 6-class	Stepwise remove hunt	-137724.9	276653.6	275803.8	177	11.3%	0.415
	Panel 6-class	Stepwise remove canoe	-137730.6	276631.1	275805.2	172	11.4%	0.415
	Panel 6-class	**Stepwise remove forage**	**-137735.2**	**276518.5**	**275804.3**	**167**	**11.4%**	**0.415**
	Panel 6-class	Stepwise remove trap	-137741.8	276537.4	275807.7	162	11.6%	0.416
	Panel 6-class	Stepwise remove age	-137768.8	276585.5	275831.6	147	11.7%	0.416
	Panel 6-class	Stepwise remove birdwatch	-137776.4	276606.1	275836.7	142	12.9%	0.416
	Panel 6-class	Stepwise remove hike (No Covariates)	-137788.3	276508.4	275850.6	137	13.0%	0.417

Models

DNR Staff vs Online Panel

In the jointly estimated regression model, parameters for all landscape features coded in the images showed statistically significant effects on scenic beauty (Table 2). While there were several similarities between the two groups, some statistically significant differences were also found. The intercept parameter was much more negative than that of the panelists, suggesting that staff members tended to, all things being equal, to be more critical in their aesthetic ratings. That said, the staff group also tended towards greater magnitudes in their parameters associated with landscape features, an indication that these features played an overall larger effect on their ratings.

Both groups preferred the absence of anthropogenic structures such as buildings, roads or power lines, but a significant difference was identified in the magnitude of the effect (Table 2), which would result in a shift in SBE of 41 points for staff compared to 19 points for panelists. Similar differences were found in respondent preferences for the presence of hills (resulting in shift of 50 and 30 points for staff and panelists respectively) and immature forests (51 and 22), and the absence of wet prairies (35 and 10) and tall shrubs (35 and 15). The greatest difference was seen in the effect of farmed wetlands, the absence of which was preferred by both groups, but whose effect was predicted to shift SBE by 105 points for staff, but only 21 points for panelists.

Staff and panelists did not share directionality in their preferences for all features, however. Whereas staff preferred the presence of dead trees, panelists showed a small but significant preference for their absence. Where presence of sedge meadows marginally increased scenic beauty ratings among staff, their absence increased ratings for panelists. While staff showed a strong preference for landscapes coded as having high levels of plant diversity, the panelists most preferred medium levels of plant diversity. While both groups tended to rate images with 50 to 75 percent invasive vegetation as more scenically beautiful, the effect of this attribute did not show a linear trend, suggesting that invasive species differ in how they are perceived aesthetically.

No significant differences were detected between staff and panelist perceptions of dead vegetation and marshes to which both groups preferred their absence. Nor were there significant difference in the effects of flowers, open water, or mature forests, whose presence increased scenic beauty.

Preferences for Scenic Viewscapes – The Scenic Beauty Estimation Tool (Figure 4) allows prediction of the scenic quality of any combination of coded landscape features and is useful for evaluating how staff involved in permitting decisions are likely to perceive the scenic quality of a wetland relative to how the public may perceive it. The most scenic wetland for staff is in the 89th percentile of scenic wetlands for panelists, while the most scenic wetland among panelists is in the 95th percentile for staff. Conversely, the least scenic wetlands for panelists and staff are in the eleventh and twelfth percentiles for the other group respectively (Table 3).

While differences between staff and panel perceptions did not differ markedly for the best and worst scenarios, more substantive differences emerged when presented with scenarios that involved making tradeoff among different landscape features (Table 3). These differences highlight that while there is general agreement between the two groups about how characteristics contribute to the scenic quality of wetland landscapes, differences exist in the relative importance of the characteristics relative to one another.

Table 2. *Comparison of regression model parameter estimates of landscape attributes effect on perceptions of scenic beauty between DNR Staff and online panel participants.*

		Staff		Panel					
	R^2	0.39		0.07					
	Class Size	3.4%		96.6%					
Attribute	**Level**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Wald**	**p-value**	**Wald(=)**	**p-value**
Intercept		-114.66	11.85	-13.47	3.79	106.2	**<0.001**	66.1	**<0.001**
Anthropogenic Structures	**Absent**	20.55	2.92	9.64	0.90	164.1	**<0.001**	12.7	**<0.001**
	Present	-20.55	2.92	-9.64	0.90				
Dead Trees	**Absent**	-5.93	2.99	1.72	0.92	7.5	**0.024**	6.0	**0.014**
	Present	5.93	2.99	-1.72	0.92				
Dead Vegetation	**Absent**	17.76	3.95	20.75	1.19	326.0	**<0.001**	0.5	0.470
	Present	-17.76	3.95	-20.75	1.19				
Flowers	**Absent**	-3.16	2.83	-4.03	0.89	21.7	**<0.001**	0.1	0.770
	Present	3.16	2.83	4.03	0.89				
Open Water	**Absent**	-7.12	3.69	-5.55	1.17	26.1	**<0.001**	0.2	0.690
	Present	7.12	3.69	5.55	1.17				
Bare Soil	**Absent**	1.01	3.01	-4.81	0.96	25.2	**<0.001**	3.4	0.066
	Present	-1.01	3.01	4.81	0.96				
Hill	**Absent**	-25.17	3.60	-15.40	1.07	255.4	**<0.001**	6.8	**0.009**
	Present	25.17	3.60	15.40	1.07				
Plant Diversity	**Low**	-49.24	5.40	-1.99	1.69	86.7	**<0.001**	70.2	**<0.001**
	Medium	19.58	4.35	2.50	1.35				
	High	29.66	4.90	-0.51	1.50				
Invasive Vegetation Extent	**Less than 5**	16.75	5.70	20.67	1.78	534.8	**<0.001**	22.4	**<0.001**
	5 to 25	-33.81	5.26	-15.67	1.64				
	25 to 50	-21.73	7.52	-7.08	2.38				
	50 to 75	28.11	8.09	21.64	2.65				
	75 or more	10.68	7.08	-19.57	2.14				
Type: Wet Prairie	**Absent**	17.64	3.77	5.06	1.19	40.1	**<0.001**	10.1	**0.002**
	Present	-17.64	3.77	-5.06	1.19				
Type: Marsh	**Absent**	4.81	3.81	3.09	1.19	8.3	**0.016**	0.2	0.670
	Present	-4.81	3.81	-3.09	1.19				
Type: Mature Forest	**Absent**	-13.87	4.28	-14.02	1.35	118.2	**<0.001**	0.0	0.970
	Present	13.87	4.28	14.02	1.35				
Type: Immature Forest	**Absent**	-25.75	5.53	-11.19	1.71	64.4	**<0.001**	6.3	**0.012**
	Present	25.75	5.53	11.19	1.71				
Type: Sedge Meadow	**Absent**	-1.63	3.62	8.29	1.09	57.8	**<0.001**	6.9	**0.009**
	Present	1.63	3.62	-8.29	1.09				
Type: Tall Shrub	**Absent**	17.48	4.17	7.32	1.34	47.3	**<0.001**	5.4	**0.020**
	Present	-17.48	4.17	-7.32	1.34				
Type: Farmed	**Absent**	52.92	6.73	10.81	2.07	89.2	**<0.001**	35.8	**<0.001**
	Present	-52.92	6.73	-10.81	2.07				

	Wetland Profile
Anthropogenic Structures	Absent
Dead Trees	Present
Dead Vegetation	Absent
Flowers	Present
Open Water	Present
Bare Soil	Absent
Hill	Present
Plant Diversity	High
Invasive Vegetation Extent	50 to 75
Type : Wet Prairie	Absent
Type: Marsh	Absent
Type: Mature Forest	Present
Type: Immature Forest	Present
Type: Sedge Meadow	Present
Type: Tall Shrub	Absent
Type: Farmed	Absent
Predicted Scenic Beauty	**Relative Score**
Staff	**100%**
Panel	**89%**

Calculations	Staff	Panel
Intercept	-114.7	-13.5
Anthropogenic Structures	20.5	9.6
Dead Trees	5.9	-1.7
Dead Vegetation	17.8	20.7
Flowers	3.2	4.0
Open Water	7.1	5.6
Bare Soil	1.0	-4.8
Hill	25.2	15.4
Plant Diversity	29.7	-0.5
Invasive Vegetation Extent	28.1	21.6
Type : Wet Prairie	17.6	5.1
Type: Marsh	4.8	3.1
Type: Mature Forest	13.9	14.0
Type: Immature Forest	25.8	11.2
Type: Sedge Meadow	1.6	-8.3
Type: Tall Shrub	17.5	7.3
Type: Farmed	52.9	10.8
Predicted SBE	157.9	99.7
Max Possible Predicted SBE	157.9	132.3
Min Possible Predicted SBE	-412.5	-156.7
Range of Possible Predicted SBE	570.4	289.0
Relative Score:	**100%**	**89%**

Figure 4. *Screenshot of Scenic Beauty Estimation tool comparing relative perceptions of DNR staff and members of an online panel.*

Table 3. *Most, least and greatest difference scenic wetland landscape viewscapes for DNR Staff versus Online Panelists. Differences between the groups are identified by underlined italics.*

	Most Scenic		Least Scenic		Biggest difference	
	Staff	**Panel**	**Staff**	**Panel**	**Staff**	**Panel**
Anthropogenic Structures	Absent	Absent	Present	Present	Absent	Present
Dead Trees	*Present*	*Absent*	*Absent*	*Present*	Present	Absent
Dead Vegetation	Absent	Absent	Present	Present	Present	Absent
Flowers	Present	Present	Absent	Absent	Absent	Present
Open Water	Present	Present	Absent	Absent	Present	Absent
Bare Soil	*Absent*	*Present*	*Present*	*Absent*	Absent	Present
Hill	Present	Present	Absent	Absent	Present	Absent
Plant Diversity	*High*	*Medium*	Low	Low	High	Low
Invasive Vegetation Extent	50 to 75	50 to 75	*5 to 25*	*75 or more*	75 or more	5 to 25
Type: Wet Prairie	Absent	Absent	Present	Present	Absent	Present
Type: Marsh	Absent	Absent	Present	Present	Absent	Present
Type: Mature Forest	Present	Present	Absent	Absent	Absent	Present
Type: Immature Forest	Present	Present	Absent	Absent	Present	Absent
Type: Sedge Meadow	*Present*	*Absent*	*Absent*	*Present*	Present	Absent
Type: Tall Shrub	Absent	Absent	Present	Present	Absent	Present
Type: Farmed	Absent	Absent	Present	Present	Absent	Present
Percentile: Staff	100%	95%	0%	11%	85%	12%
Percentile: Panel	89%	100%	12%	0%	48%	38%

Latent Class Regression of Online Panel Data

The latent class regression analysis found a six-class solution optimized information from the model (Table 1). The six classes ranged in size from 30 percent of respondents to eight percent (Table 4).

Class 1 (29.8%) preferred the presence of flowers, hills, bare soil and both immature and mature forest. They preferred the absence of anthropogenic structures, dead trees, dead vegetation, wet prairie, sedge meadow, tall shrub and farmed wetland. They were indifferent to the presence or absence of open water and marshes. In addition, class tended to prefer low species diversity and less than five percent invasive vegetation.

Class 2 (19.2%) preferred the presence of anthropogenic structures, open water, hills, dead trees and mature forest. They preferred the absence of flowers, dead vegetation, wet prairie, sedge meadow, and farmed wetland. They were indifferent to plant diversity, the presence or absence of immature forest, tall shrubs, marshes and bare soil. In addition, class tended to prefer wetlands with 50 to 75 percent invasive vegetation.

Class 3 (18.5%) preferred the presence of flowers, open water, bare soil, hills, and immature forest. They preferred the absence of anthropogenic structures, dead trees, dead vegetation, wet prairie, and farmed wetland. They were indifferent to the presence or absence of mature forest, sedge meadow, tall shrubs, and marshes. In addition, class tended to prefer wetlands with medium plant diversity and less than five percent invasive vegetation.

Class 4 (16.1%) preferred the presence of open water, hills, and immature forest. They preferred the absence of anthropogenic structures, dead trees, dead vegetation, and farmed wetland. They were indifferent to the presence or absence of flowers, bare soil, wet prairie, mature forest, sedge meadow, tall shrubs, and marshes. In addition, class tended to prefer wetlands with medium plant diversity and less than five percent invasive vegetation.

Class 5 (8.2%) preferred the presence of anthropogenic structures, dead trees, open water, and hills. They preferred the absence of flowers, wet prairie, and farmed wetland. They were indifferent to the presence or absence of dead vegetation, bare soil, mature and immature forest, sedge meadow, tall shrubs, and marshes. In addition, class tended to prefer wetlands with medium plant diversity and more than 75 percent invasive vegetation.

Class 6 (8.2%) preferred the presence of flowers, and immature forest, mature forest and farmed wetland. They preferred the absence of anthropogenic structures, dead trees, dead vegetation, open water, hills, wet prairie, marsh, sedge meadow and tall shrub wetlands. They were indifferent to the presence or absence of bare soil. In addition, class tended to prefer wetlands with low plant diversity and 50 to 75 percent invasive vegetation.

Only four respondent characteristics were found to provide significant information to inform latent class membership (Table 5), namely age, and participation in three recreational activities – hiking, birdwatching and trapping (Table 5, Table 6). Overall, class 1 tended to reflect the population characteristics on these variables, while the other latent classes tended to deviate from the population on one or more. Members of Class 2 tended to be most likely to hike, while class 4 had a higher likelihood than other classes to participate in birdwatching, Class 5 members tended to be both older than the other classes and most likely to participate in trapping, while class 3 members were more likely to be younger than the other classes. Class 6, while like class 1 in age distribution, was less likely to participate in any of the three recreational activities included in the model.

Preferences for Scenic Viewscapes – As with the staff/panel model, we constructed a decision support tool that calculates SBEs for each of the six latent classes (Figure 5) In addition to these calculations, the tool also incorporated the class membership model to predict the likelihood of individuals described by a set of covariate values belonging any one of the classes. These probabilities are used to weight the SBEs to predict the relative scenic beauty value for those individuals.

Looking at the scenarios that both maximize and minimize the scenic beauty score for each latent class reveals considerably more heterogeneity among groups within the online panel than was observed in comparisons between the panel as a whole and department staff (Table 7).

Table 4. *Comparison of regression model parameter estimates of landscape attributes effect on perceptions of scenic beauty among six latent classes of panel participants.*

		Class 1		Class 2		Class 3		Class 4		Class 5		Class 6					
	R^2	0.11		0.25		0.08		0.27		0.24		0.30					
	Class Size	29.8%		19.2%		18.5%		16.1%		8.2%		8.2%					
Attribute	**Level**	**Beta**	**s.e.**	**s.e.**	**Beta**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Wald**	**p-value**	**Wald(=)**	**p-value**
Intercept		48.47	6.69	-34.09	9.57	-20.79	12.12	-67.68	8.38	-135.65	11.42	97.37	11.12	372.8	**<0.001**	369.3	**<0.001**
Anthropogenic Structures	**Absent**	9.25	1.87	-6.62	2.32	24.67	2.16	19.76	2.84	-2.49	2.64	7.84	2.67	298.7	**<0.001**	156.5	**<0.001**
	Present	-9.25	1.87	6.62	2.32	-24.67	2.16	-19.76	2.84	2.49	2.64	-7.84	2.67				
Dead Trees	**Absent**	4.59	1.52	-2.93	2.12	2.71	2.05	1.99	2.02	-7.24	2.61	9.40	2.69	34.7	**<0.001**	29.0	**<0.001**
	Present	-4.59	1.52	2.93	2.12	-2.71	2.05	-1.99	2.02	7.24	2.61	-9.40	2.69				
Dead Vegetation	**Absent**	26.75	2.08	9.65	2.90	30.65	2.83	23.87	3.04	-0.61	3.38	28.54	3.51	523.7	**<0.001**	84.3	**<0.001**
	Present	-26.75	2.08	-9.65	2.90	-30.65	2.83	-23.87	3.04	0.61	3.38	-28.54	3.51				
Flowers	**Absent**	-7.42	1.49	4.64	2.08	-14.25	2.16	-5.02	2.79	14.59	2.60	-7.37	2.65	134.8	**<0.001**	100.9	**<0.001**
	Present	7.42	1.49	-4.64	2.08	14.25	2.16	5.02	2.79	-14.59	2.60	7.37	2.65				
Open Water	**Absent**	2.64	2.07	-9.95	2.92	-9.99	2.73	-17.15	2.88	-27.01	3.76	24.69	3.74	191.8	**<0.001**	152.9	**<0.001**
	Present	-2.64	2.07	9.95	2.92	9.99	2.73	17.15	2.88	27.01	3.76	-24.69	3.74				
Bare Soil	**Absent**	-6.13	1.60	-4.30	2.21	-10.84	2.14	-3.52	2.24	0.26	2.63	-2.40	2.87	57.0	**<0.001**	13.4	**0.020**
	Present	6.13	1.60	4.30	2.21	10.84	2.14	3.52	2.24	-0.26	2.63	2.40	2.87				
Hill	**Absent**	-5.04	1.93	-16.58	2.48	-20.11	2.28	-28.23	2.61	-31.44	3.10	7.25	3.33	420.1	**<0.001**	146.0	**<0.001**
	Present	5.04	1.93	16.58	2.48	20.11	2.28	28.23	2.61	31.44	3.10	-7.25	3.33				
Plant Diversity	**Low**	7.74	2.84	-2.77	4.05	-3.36	4.55	-12.82	3.92	-20.00	5.18	13.08	5.14	65.2	**<0.001**	54.6	**<0.001**
	Medium	-4.71	2.26	2.67	3.17	8.96	3.16	9.71	3.01	13.93	3.98	-3.70	3.99				
	High	-3.02	2.50	0.11	3.49	-5.61	3.54	3.11	3.59	6.07	4.42	-9.38	4.69				
Invasive Vegetation Extent	**Less than 5**	29.81	3.02	8.50	4.13	36.10	4.39	25.07	4.17	0.79	4.91	17.67	5.28	928.2	**<0.001**	254.6	**<0.001**
	5 to 25	-7.52	2.81	-13.91	3.83	-26.13	3.61	-28.94	3.44	-18.30	4.66	-7.46	4.97				
	25 to 50	-10.17	3.99	-7.07	5.34	-8.95	5.01	-7.66	5.14	-20.21	6.60	-0.23	6.82				
	50 to 75	27.75	4.43	12.55	6.58	22.75	6.10	9.69	5.60	13.39	7.58	46.20	7.92				
	75 or more	-39.87	3.73	-0.08	5.45	-23.77	7.19	1.83	4.82	24.33	6.05	-56.18	6.46				
Type: Wet Prairie	**Absent**	3.99	1.99	9.63	2.77	3.77	2.56	0.41	2.63	6.43	3.42	4.58	3.58	26.7	**<0.001**	5.7	0.340
	Present	-3.99	1.99	-9.63	2.77	-3.77	2.56	-0.41	2.63	-6.43	3.42	-4.58	3.58				
Type: Marsh	**Absent**	2.26	2.00	1.78	2.75	3.42	2.52	-1.02	2.57	5.30	3.34	9.63	3.74	13.9	**0.031**	6.3	0.280
	Present	-2.26	2.00	-1.78	2.75	-3.42	2.52	1.02	2.57	-5.30	3.34	-9.63	3.74				
Type: Mature Forest	**Absent**	-23.70	2.25	-10.82	3.20	-14.45	2.95	-9.33	2.94	-4.74	3.85	-17.87	4.03	197.7	**<0.001**	30.1	**<0.001**
	Present	23.70	2.25	10.82	3.20	14.45	2.95	9.33	2.94	4.74	3.85	17.87	4.03				
Type: Immature Forest	**Absent**	-11.96	2.95	-4.96	3.90	-17.15	3.74	-18.30	3.71	2.06	4.89	-7.37	4.83	77.2	**<0.001**	16.2	**0.006**
	Present	11.96	2.95	4.96	3.90	17.15	3.74	18.30	3.71	-2.06	4.89	7.37	4.83				
Type: Sedge Meadow	**Absent**	11.81	1.84	5.91	2.44	9.95	2.29	-2.83	2.56	-0.42	3.17	21.76	3.26	118.3	**<0.001**	54.0	**<0.001**
	Present	-11.81	1.84	-5.91	2.44	-9.95	2.29	2.83	2.56	0.42	3.17	-21.76	3.26				
Type: Tall Shrub	**Absent**	7.32	2.22	7.64	2.99	3.35	2.90	1.02	2.76	5.60	3.70	15.12	4.07	38.0	**<0.001**	9.8	0.082
	Present	-7.32	2.22	-7.64	2.99	-3.35	2.90	-1.02	2.76	-5.60	3.70	-15.12	4.07				
Type: Farmed	**Absent**	-11.28	3.54	7.54	4.85	18.74	5.39	31.19	4.82	42.86	5.84	-18.78	6.33	142.6	**<0.001**	120.6	**<0.001**
	Present	11.28	3.54	-7.54	4.85	-18.74	5.39	-31.19	4.82	-42.86	5.84	18.78	6.33				

Table 5. *Covariate parameters predicting membership in each of six latent classes based on landscape aesthetic perceptions.*

		Class 1		Class 2		Class 3		Class 4		Class 5		Class 6			
Covariate	**Level**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Beta**	**s.e.**	**Wald**	**p-value**
Intercept		1.29	0.49	-0.45	1.41	-0.42	1.41	-0.34	1.41	-0.09	0.53	0.01	0.51	30.8	**<0.001**
Age	**Under 18**	1.63	1.45	-1.62	4.14	-1.83	4.14	-1.50	4.14	1.71	1.47	1.60	1.54	34.2	**0.003**
	18 to 34	-0.37	0.49	0.17	1.39	1.30	1.39	0.14	1.39	-0.98	0.53	-0.25	0.54		
	35 to 64	-0.60	0.49	0.52	1.39	0.87	1.39	0.57	1.39	-0.51	0.51	-0.85	0.54		
	65 and older	-0.66	0.50	0.93	1.39	-0.33	1.40	0.79	1.39	-0.22	0.52	-0.51	0.54		
Hike	**No**	0.11	0.08	-0.36	0.11	0.09	0.10	-0.17	0.10	0.00	0.11	0.33	0.12	20.2	**0.001**
	Yes	-0.11	0.08	0.36	0.11	-0.09	0.10	0.17	0.10	0.00	0.11	-0.33	0.12		
Birdwatch	**No**	-0.12	0.08	0.01	0.10	0.06	0.10	-0.34	0.10	0.23	0.13	0.17	0.14	15.1	**0.010**
	Yes	0.12	0.08	-0.01	0.10	-0.06	0.10	0.34	0.10	-0.23	0.13	-0.17	0.14		
Trap	**No**	0.38	0.24	0.16	0.31	-0.32	0.18	-0.21	0.23	-0.53	0.22	0.52	0.42	12.0	**0.034**
	Yes	-0.38	0.24	-0.16	0.31	0.32	0.18	0.21	0.23	0.53	0.22	-0.52	0.42		

Table 6. *Distributions of covariates for six latent classes.*

		Class1	**Class2**	**Class3**	**Class4**	**Class5**	**Class6**
	Class Size	29.8%	19.2%	18.5%	16.1%	8.2%	8.2%
Covariate: Age	**Under 18**	0.1%	0.0%	0.0%	0.0%	0.2%	0.1%
	18 to 34	31.2%	18.3%	45.0%	17.4%	18.9%	36.8%
	35 to 64	43.3%	46.0%	46.7%	48.0%	45.9%	33.0%
	65 and older	25.4%	35.7%	8.3%	34.5%	34.6%	29.9%
Covariate: Hike	**No**	45.3%	26.8%	43.2%	31.5%	44.6%	59.9%
	Yes	54.8%	73.2%	56.8%	68.6%	55.4%	40.1%
Covariate: Birdwatch	**No**	62.3%	61.3%	71.1%	45.5%	73.8%	76.9%
	Yes	37.7%	38.7%	29.0%	54.5%	26.2%	23.1%
Covariate: Trap	**No**	97.8%	97.8%	91.4%	95.1%	90.9%	98.4%
	Yes	2.2%	2.2%	8.6%	4.9%	9.1%	1.6%

	Wetland Profile
Anthropogenic Structures	Absent
Dead Trees	Absent
Dead Vegetation	Absent
Flowers	Present
Open Water	Absent
Bare Soil	Present
Hill	Present
Plant Diversity	High
Invasive Vegetation Extent	Less than 5
Type : Wet Prairie	Absent
Type: Marsh	Absent
Type: Mature Forest	Present
Type: Immature Forest	Present
Type: Sedge Meadow	Absent
Type: Tall Shrub	Absent
Type: Farmed	Present

	Relative Score
Class 1 (29.8%)	97%
Class 2 (19.2%)	71%
Class 3 (18.5%)	84%
Class 4 (16.1%)	73%
Class 5 (8.2%)	40%
Class 6 (8.2%)	87%
Weighted Total	**84%**

Calculations	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Intercept	48.5	-34.1	-20.8	-67.7	-135.7	97.4
Anthropogenic Structures	9.3	-6.6	24.7	19.8	-2.5	7.8
Dead Trees	4.6	-2.9	2.7	2.0	-7.2	9.4
Dead Vegetation	26.7	9.7	30.6	23.9	-0.6	28.5
Flowers	7.4	-4.6	14.2	5.0	-14.6	7.4
Open Water	2.6	-10.0	-10.0	-17.1	-27.0	24.7
Bare Soil	6.1	4.3	10.8	3.5	-0.3	2.4
Hill	5.0	16.6	20.1	28.2	31.4	-7.3
Plant Diversity	-3.0	0.1	-5.6	3.1	6.1	-9.4
Invasive Vegetation Extent	29.8	8.5	36.1	25.1	0.8	17.7
Type : Wet Prairie	4.0	9.6	3.8	0.4	6.4	4.6
Type: Marsh	2.3	1.8	3.4	-1.0	5.3	9.6
Type: Mature Forest	23.7	10.8	14.5	9.3	4.7	17.9
Type: Immature Forest	12.0	5.0	17.2	18.3	-2.1	7.4
Type: Sedge Meadow	11.8	5.9	10.0	-2.8	-0.4	21.8
Type: Tall Shrub	7.3	7.6	3.3	1.0	5.6	15.1
Type: Farmed	11.3	-7.5	-18.7	-31.2	-42.9	18.8
Predicted SBE	209.4	14.1	136.3	19.8	-172.8	273.8
Max Possible Predicted SBE	220.2	84.1	208.3	130.7	53.7	339.3
Min Possible Predicted SBE	-130.3	-153.7	-236.6	-273.1	-326.9	-150.8
Range of Possible Predicted SBE	350.4	237.8	444.9	403.8	380.6	490.1
Prediction relative to Max	**96.9%**	**70.6%**	**83.8%**	**72.5%**	**40.5%**	**86.6%**

	Class Profile
Age	18 to 34
Hike	Yes
Birdwatch	No
Trap	No

	Probability of Membership
Class 1	**40.3%**
Class 2	**17.6%**
Class 3	**23.7%**
Class 4	**7.7%**
Class 5	**3.2%**
Class 6	**7.5%**

Calculations	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Intercept	1.29	-0.45	-0.42	-0.34	-0.09	0.01
Age	-0.37	0.17	1.30	0.14	-0.98	-0.25
Hike	-0.11	0.36	-0.09	0.17	0.17	0.17
Birdwatch	-0.12	0.01	0.06	-0.34	-0.34	-0.34
Trap	0.38	0.16	-0.32	-0.21	-0.21	-0.21
SUM	1.06	0.24	0.53	-0.59	-1.46	-0.62
EXP	2.90	1.27	1.71	0.55	0.23	0.54
Likelihood	**40.3%**	**17.6%**	**23.7%**	**7.7%**	**3.2%**	**7.5%**

Predicted Relative Score for profile above: 85%

Figure 5. *Screenshot of Scenic Beauty Estimation tool comparing relative perceptions among latent classes in an online panel. The lower box predicts likelihood of membership in each latent class given an individual's age and recreational activity enjoyment.*

Table 7. *Idealized most and least scenic wetland landscape viewscapes for six latent class groups of online panelists. Differences between the groups are identified by underlined italics. Features that are consistent across all six groups are bolded.*

	Most Scenic						Least Scenic					
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**
Anthropogenic Structures	Absent	*Present*	Absent	Absent	*Present*	Absent	Present	*Absent*	Present	Present	*Absent*	Present
Dead Trees	Absent	*Present*	Absent	Absent	*Present*	Absent	Present	*Absent*	Present	Present	*Absent*	Present
Dead Vegetation	Absent	Absent	Absent	Absent	*Present*	Absent	Present	Present	Present	Present	*Absent*	Present
Flowers	Present	*Absent*	Present	Present	*Absent*	Present	Absent	*Present*	Absent	Absent	*Present*	Absent
Open Water	*Absent*	Present	Present	Present	Present	*Absent*	*Present*	Absent	Absent	Absent	Absent	*Present*
Bare Soil	Present	Present	Present	Present	*Absent*	Present	Absent	Absent	Absent	Absent	*Present*	Absent
Hill	Present	Present	Present	Present	Present	*Absent*	Absent	Absent	Absent	Absent	Absent	*Present*
Plant Diversity	*Low*	Medium	Medium	Medium	Medium	*Low*	*Medium*	Low	*High*	Low	Low	High
Invasive Vegetation Extent	Less than 5	*50 to 75*	Less than 5	Less than 5	*75 or more*	*50 to 75*	*75 or more*	5 to 25	5 to 25	5 to 25	*25 to 50*	*75 or more*
Type: Wet Prairie	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**Present**	**Present**	**Present**	**Present**	**Present**	**Present**
Type: Marsh	Absent	Absent	Absent	*Present*	Absent	Absent	Present	Present	Present	*Absent*	Present	Present
Type: Mature Forest	**Present**	**Present**	**Present**	**Present**	**Present**	**Present**	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**
Type: Immature Forest	Present	Present	Present	Present	*Absent*	Present	Absent	Absent	Absent	Absent	*Present*	Absent
Type: Sedge Meadow	Absent	Absent	Absent	*Present*	*Present*	Absent	Present	Present	Present	*Absent*	*Absent*	Present
Type: Tall Shrub	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**Absent**	**Present**	**Present**	**Present**	**Present**	**Present**	**Present**
Type: Farmed	*Present*	Absent	Absent	Absent	Absent	*Present*	*Absent*	Present	Present	Present	Present	*Absent*
Percentile: Class 1	**100%**	**76%**	**89%**	**80%**	**24%**	**97%**	**0%**	**33%**	**18%**	**29%**	**64%**	**3%**
Percentile: Class 2	**69%**	**100%**	**86%**	**80%**	**74%**	**57%**	**35%**	**0%**	**13%**	**18%**	**24%**	**48%**
Percentile: Class 3	**84%**	**78%**	**100%**	**94%**	**37%**	**72%**	**17%**	**19%**	**0%**	**7%**	**54%**	**22%**
Percentile: Class 4	**69%**	**81%**	**98%**	**100%**	**58%**	**51%**	**39%**	**15%**	**6%**	**0%**	**42%**	**51%**
Percentile: Class 5	**34%**	**95%**	**79%**	**77%**	**100%**	**20%**	**72%**	**2%**	**22%**	**18%**	**0%**	**86%**
Percentile: Class 6	**91%**	**66%**	**70%**	**57%**	**20%**	**100%**	**4%**	**45%**	**31%**	**48%**	**71%**	**0%**
Weighted total:	**84%**	**85%**	**90%**	**84%**	**46%**	**75%**	**18%**	**18%**	**12%**	**19%**	**47%**	**26%**

Study Limitations

"All models are wrong, but some are useful" (Box, 1976). This study's purpose was to inform development of a decision support tool to facilitate rapid functional value assessment or other similar efforts related to natural scenic beauty. To that end, we succeeded in our efforts. The models that we developed provide insights into similarities and differences among perceptions of wetland landscapes between technical experts (department staff) and nonexperts (online panel), as well as a sense of the heterogeneity of preference present in the Wisconsin population. These models are, however, not without their limitations, and the results developed offer a starting point rather than an end to the issue of assessing natural scenic beauty functional values in wetland management.

The usefulness of these models can be improved most markedly in two ways. The first of these improvements is related to the quantity and quality of biophysical data captured in the photo catalogue. This project relied on opportunistic contributions from staff during their field season. In other words, the data were collected as an additional task outside their normal duties. Additional resources to improve the detail and rigor of this process would enable future models to draw from a larger catalogue of images coded with more specific information. For example, rather than grouping all anthropogenic structures together, separate estimates for different types of structures may become possible. Similarly, the presence or absence of key invasive taxa may clarify insights about the effects of nonnative species on natural scenic beauty perceptions.

The second improvement is related to the quality and quantity of rating information. While the online panel was cost effective, it was subject to data quality issues. Resources to improve survey data collection through a probability sample survey would also improve the model.

Finally, preference models are designed to provide insights into what people like or dislike. While the images that were evaluated were taken at physical locations throughout Wisconsin, the models we developed focus on the effects of individual landscape features on perceptions. When aggregated, the features that are most preferred may not exist. Therefore, a future project would be well served to develop preference models that align with available Geographic Information System layers to map the distribution of SBEs on the landscape. Such an effort could provide the basis for identifying potentially scenic wetlands and establishing *a priori* benchmarks for natural scenic beauty values. From these values, thresholds could be set to guide holistic management decisions that consider not just the scenic quality of a given wetland in permitting decisions, but how the scenic quality of the wetland relates to others in the state.

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